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Quality of Spindle-Harvested Cotton

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Abstract. *Three cotton varieties were grown under furrow-irrigated conditions in southern New Mexico and harvested with three different spindle picker machine/speed combinations. Results for harvest losses and trash content showed a highly significant interaction between variety and machine/speed combination. This interaction caused difficulty in interpreting results from this 1-year study. Therefore, a follow-up study is planned.*

Keywords. Cotton ginning, harvesting,

Introduction

Spindle picking of cotton was developed in the 1940's as a means to speed up and reduce the cost of harvest. Prior to this, all cotton was hand-harvested. Over time, spindle picking has become the preferred method of harvesting most cotton in the U.S. Improvements to spindle pickers over the years have primarily focused on increasing the number of rows that can be harvested with 1 pass of the machine from 1 row to up to 6 rows; as well as increasing the travel speed of the harvester from around 1.5 to up to 4 miles per hour.

Improvements to the cotton harvester have primarily focused on increased capacity in order to reduce the cost of harvesting. As cotton harvesters have gotten bigger and faster, spindle speeds have increased. As the speed has increased, cotton fibers can wrap more tightly around the spindle. Spindle sizes have also decreased in both diameter and length in order to reduce the weight of the picker head. As spindle diameter decreases, cotton fibers will wrap around the spindle more and become tighter on the spindle. As spindle length decreases, cotton plants must be further compressed as they pass through the picking zone. These changes have resulted in a general decrease in cotton fiber quality, particularly regarding spindle twists, preparation, and neps.

Spindle pickers require meticulous adjustment in order to minimize harvest losses and to maximize fiber quality (Williford et al, 1994). Avoiding the harvest of high moisture cotton is another requirement to minimize harvest losses and to maximize fiber quality (Mayfield et al, 1998). Deviations from these highly recommended practices will result in significant quality degradation and increased harvest losses, both of which can cost the grower.

Objective

The objective of this study was:

- To compare fiber quality, harvest losses, and trash content of three varieties of spindle-picked cotton using three machine/speed harvest combinations.

Methods and Materials

Test plots approximately 1.5 acres in area of each of three cotton varieties were grown during the 2002 growing season at the Leyendecker Plant Science Research Center, Las Cruces, New Mexico. The three cotton varieties grown were: Delta Pine 90B, a conventional upland cotton; Acala 1517-99, an upland cotton with enhanced staple length; and Pima S7, a conventional Pima cotton. The Pima cotton was planted on April 15 and the upland varieties were both planted on April 19. All cotton was grown on ridged 40 inch rows and furrow irrigated as needed during the growing season. Chemical herbicides and insecticides were applied as needed and in accordance to customary practice for the growing region. In preparation for harvest, a chemical defoliant was applied to the cotton on October 11. Due to rainy weather, harvest was delayed until late November.

Harvest occurred from November 20 to November 22, 2002. Two machines were used to harvest the cotton, an International Harvester model 120 1-row spindle picker and an International Harvester model 1822 2-row spindle picker. The model 120 was capable of operating at 2 speeds. Results from the three machine/speed harvest combinations were compared for all three varieties tested. Each test lot consisted of 2 adjacent rows of cotton, each about 750 feet long. Four replications of each combination of test conditions were conducted. Seed cotton harvested from each lot was dumped into a trailer for temporary storage. Two seed cotton samples of about 60 grams each were randomly selected and placed

in sealed metal cans for subsequent seed cotton moisture determination. Black plastic sheeting was placed on top of each lot in order to keep the lots separated for subsequent ginning and fiber quality analysis. Ambient air temperature and relative humidity in a shaded location were measured with a digital psychrometer during the five to ten minutes required to harvest each lot.

Spindles were different for the two machines studied. The 1-row picker used 5/8 inch spindles that had 2 3/4 inches of the spindle tip extend into the picking zone. Picking zone width was adjusted to 4 inches at the narrowest part. Note that this was a larger gap between the spindle tip and the compressor sheet than intended or desired. The 2-row picker used 1/2 inch spindles that had 2 3/8 inches of the spindle tip extend into the picking zone. Picking zone width for the 2-row picker was adjusted to 3 inches at the narrowest part.

Ground speed of each spindle picker was determined by measuring the time required for the picker to travel 100 feet as it was operating in the field. A proximity tachometer was mounted on the drive shaft to the model 120 1-row picker head to measure its rotational speed. Spindle speeds for the 1-row picker were determined by multiplying the measured drive shaft speed by the appropriate overall gear ratio for the spindle drive. Spindle speeds for the model 1822 2-row picker were obtained from the manufacturer.

Harvest losses were measured using an area frame that measured 40 inches wide (the row width) by 78.5 inches long and enclosed an area of 0.0005 acre. Before the cotton picker passed, the frame was placed across 1 row, with the center of the frame n the row, and any cotton on the ground was cleaned out of the way. The area was marked and the frame removed. After the picker passed, the frame was returned to the same location. Cotton remaining on the plant was hand-picked and collected as a sample and cotton that was on the ground was hand picked and collected as another sample. All samples were weighed, and harvest losses were computed as a percent of the total harvested yield.

Individual seed cotton lots were manually unloaded from the trailers into portable boxes, then weighed, and unloaded from the boxes using a suction pipe during seed cotton cleaning. Seed cotton cleaning equipment included a green boll trap, three separators, two cylinder cleaners, and a stick machine. Dryers in the system were not operated. The cylinder cleaners and stick machine were in a cylinder – stick – cylinder arrangement. All trash removed from the seed cotton was collected and weighed. Weights from each machine from each test lot were recorded so that any possible differences among harvest treatments could be determined. Before cleaning, two seed cotton samples of about 60 grams each were randomly selected and placed in sealed metal cans for subsequent seed cotton moisture determination and an additional two samples of about 250 grams were randomly selected and placed in plastic bags for subsequent fractionation analysis.

Upland cotton test lots (the varieties Delta Pine 90B and Acala 1517-99) were ginned using a saw gin stand fed by an extractor-feeder. One saw lint cleaner was used. Between the feeder and the gin stand, two seed cotton samples of about 60 grams each were randomly selected and placed in sealed metal cans for subsequent seed cotton moisture determination and an additional two samples of about 250 grams were randomly selected and placed in plastic bags for subsequent fractionation analysis. Two samples of the seed were collected from the seed conveying pipe and placed in sealed moisture cans for subsequent seed moisture, seed germination, seed trash, and seed damage analysis. Just before the ginned lint entered the bale press, two lint samples of about 30 grams each were randomly selected and placed in sealed metal cans for subsequent cotton lint moisture determination. Ginned lint was packaged into bales and shipped to the USDA, ARS, Cotton Quality Research Unit in Clemson, S.C. for HVI, AFIS, trash, rotor spinning, and vortex spinning tests.

Results and Discussion

The model 120 1-row picker operated at an engine speed of 1560 rpm in low drum speed, but engine speed was reduced to 1510 rpm when loaded more at the higher drum speed operation. In both cases, ground speed was 1.9 miles per hour. Spindle speed was 2000 rpm and drum speed was 2.0 miles per hour for low speed operation, but increased to 2890 rpm and 2.75 miles per hour, respectively, when operated at the higher speed (Table 1). Engine speed for the model 1822 2-row picker was 2650 rpm, but ground speed was limited to 1.6 miles per hour. Ground speed could have been greater, but the operator chose to limit ground speed in order to reduce down time due to plugging of the feed unit of the picker head. Spindle speed for this picker was in excess of 3000 rpm and drum speed exceeded 2.0 miles per hour.

Table 1. Picker operating speeds.

Machine/speed combination	1-row, low speed	1-row, high speed	2-row
Engine speed, rpm	1560	1510	2650
Ground speed, miles per hour	1.9	1.9	1.6
Spindle speed, rpm	2000	2890	> 3000
Drum speed, miles per hour	2.0	2.75	> 2.0

Harvest occurred from November 20 – 22, 2002, when weather conditions became favorable for harvest. Harvest generally began around 10:00 each morning and proceeded until 3:00 each afternoon, with a ½-hour lunch break. Ambient air temperature (shade) for the harvest period ranged from 51 to 68 degrees Fahrenheit and relative humidity (shade) ranged from 10 to 26 percent (Table 2). Seed cotton moisture when the cotton was picked was relatively low, ranging from 4.6 to 7.5 percent, dry basis. The Delta Pine variety was slightly drier than the other two varieties when harvested. The Acala variety was slightly drier than the Pima variety when harvested. Variability in air temperature and relative humidity and seed cotton moisture followed typical diurnal patterns, with lower air temperature and higher relative humidity and seed cotton moisture in the morning than in the afternoon. The Acala and Pima varieties had large pre-harvest losses due to wet weather and winds prior to harvest, thus yields for these varieties were not as great as for the Delta Pine variety (Table 2).

Table 2. Harvest dates, air conditions, and cotton moistures.

Cotton variety	Harvest dates	Air temperature, degrees F	Air relative humidity, percent	Seed cotton moisture at harvest, percent d.b.	Lint yield from harvested seed cotton, bales/acre
Delta and Pine Land 90B	11/20	60 – 67	10 – 20	4.6 – 5.4	3.0
Acala 1517-99	11/20 – 11/21	51 – 65	13 – 24	5.2 – 6.2	2.25
Pima S7	11/21 – 11/22	54 - 68	13 - 26	5.2 – 7.5	1.75

Harvest losses were expressed as percent of total yield for comparative and statistical analyses. Lower percentages are desirable. Cotton remaining on the plant after the picker passed ranged from 2.2 to 6.4 percent of the harvested yield (Figure 1). For the Delta Pine variety, the percent of cotton remaining on the plant averaged slightly over 3 percent and was not significantly different among the three machine/speed combinations. For the Acala and Pima varieties, the percent of cotton remaining on the plant was significantly lower for the 1-row, high speed machine/speed combination than for the 2-row machine or for the 1-row, low-speed machine/speed combination. With the Acala variety, the percent cotton remaining on the plant was nearly three times higher for the 1-row, low speed and 2-row machine/speed combinations than for the 1-row, high speed combination. For the Pima variety, the percentage of cotton remaining on the plant was only slightly greater for the 2-row machine than for the 1-row, high speed combination, but was over 2 times greater for the 1-row, low speed than for the 1-row, high speed picker combination. Differences in the feeding mechanisms and adjustments made to the picker heads are likely responsible for some of the differences noted. Results are preliminary and further studies are needed to corroborate the results presented before drawing conclusions.

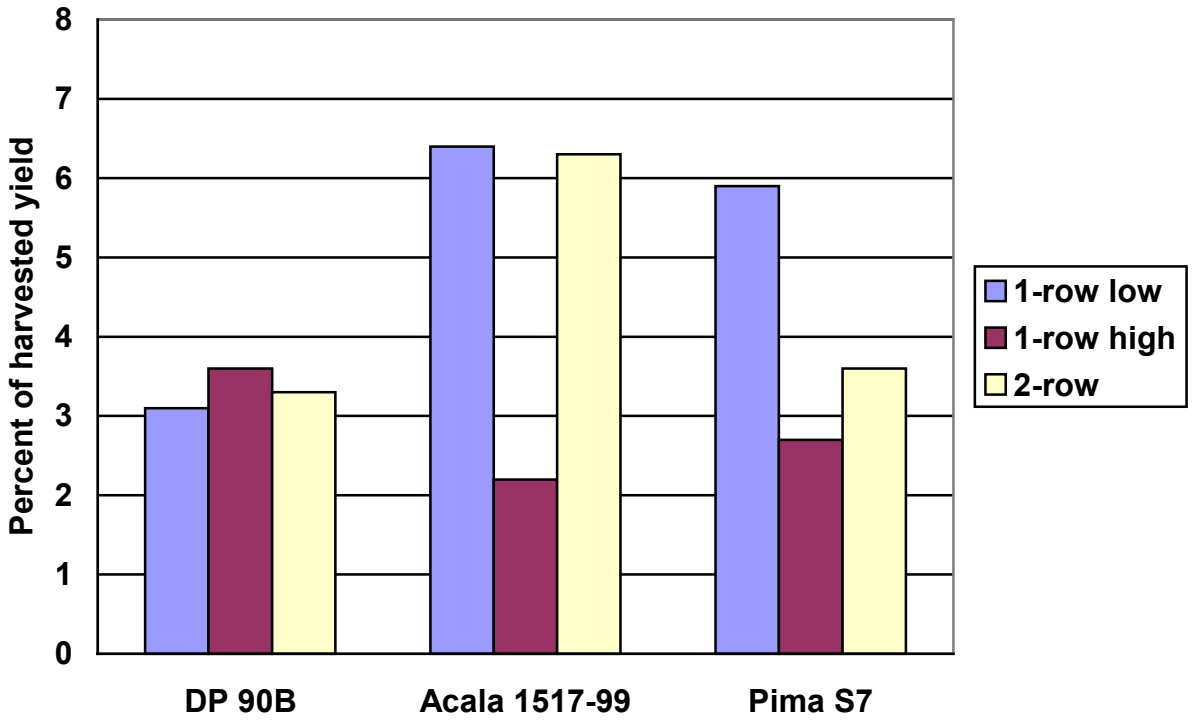

Figure 1. Portion of harvest loss consisting of cotton not removed from the plant during picking, expressed as a percent of the harvested yield.

Harvest losses also included seed cotton that was removed from the plant, but dropped to the ground instead of being conveyed to the basket. Cotton that was dropped ranged from 5.6 to 31.0 percent of the harvested yield (Figure 2). For the Delta Pine variety, the percent cotton dropped was slightly over 7 percent for the 2-row picker, which was significantly greater than a value slightly under 6 percent for the 1-row picker. Differences between the two picking speeds for the 1-row picker were not significant for this variety. For the Acala variety and Pima varieties, cotton dropped with the 2-row picker was significantly less than that for the 1-row

picker at either operating speed. Differences in the conveying air velocity, as well as differences in the width of the picking zone are likely to have contributed to the differences in dropped cotton percentages. Results are preliminary and further studies are needed to corroborate the results presented before drawing conclusions.

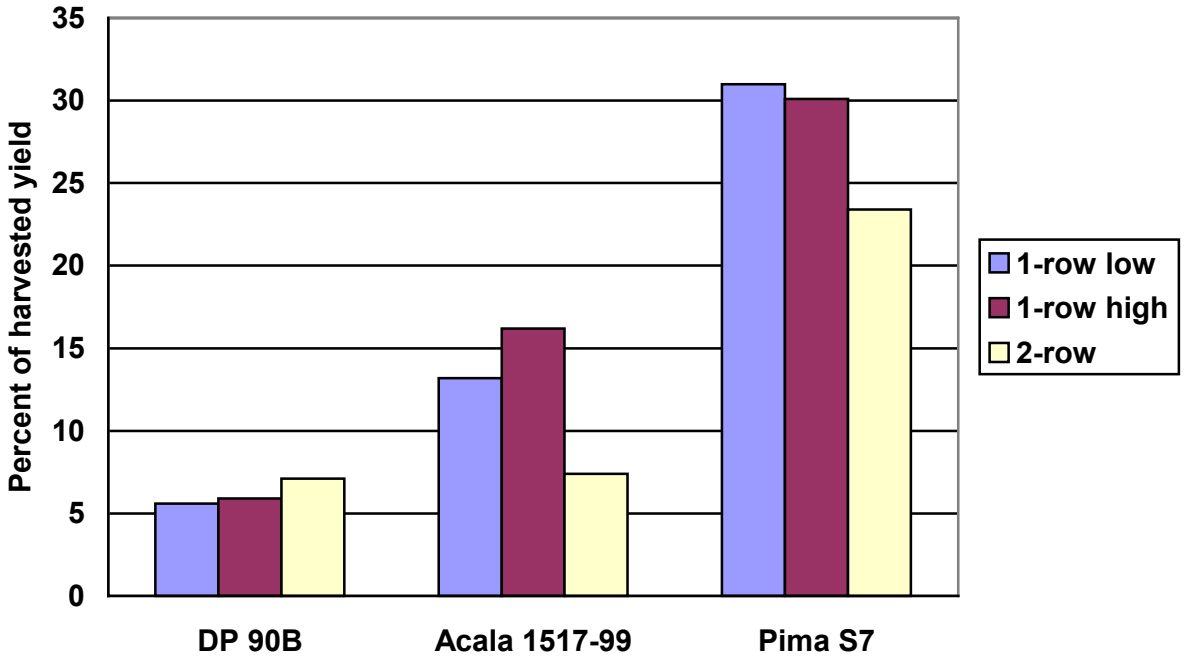

Figure 2. Portion of harvest loss consisting of cotton dropped to the ground after being removed from the plant during picking, expressed as a percent of the harvested yield.

Trash removed during seed cotton cleaning ranged from 4.7 to 10.1 percent of the total yield (Figure 3). This range is typical for cotton harvest. No significant differences were observed for total trash removed or for any of the individual components of the cleaning process between the 1-row picker operated at low speed and the 1-row picker operated at high speed for all three varieties studied. The 2-row picker had significantly more overall trash than the other picker at either speed with the Delta Pine and Acala varieties, but had less overall trash with the Pima variety. No significant differences were observed among the individual components of the cleaning process. Results are preliminary and further studies are needed to corroborate the results presented before drawing conclusions.

Results of the fiber quality analyses were not yet available at the time this manuscript was written. Contact the author for further information.

Conclusion

Three cotton varieties (Delta Pine 90B, Acala 1517-99, and Pima S7) were grown under furrow-irrigated conditions in southern New Mexico using typical agronomic practices and chemical applications for the region. Cotton was harvested in late November 2002 using two different cotton pickers (a model 120, 1-row picker and a model 1822, 2-row picker). Each picker had a different spindle design and spindle speeds were different. One picker was operated at two speeds to make a total of three different spindle picker machine/speed combinations in the test.

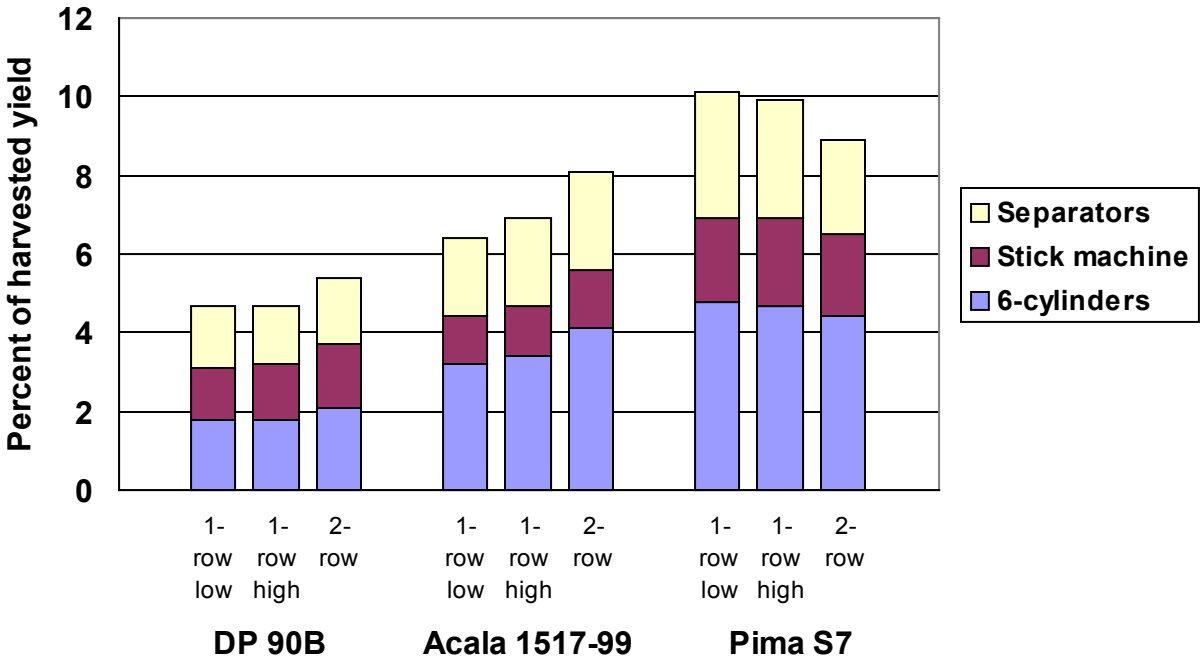

Figure 3. Trash removed from seed cotton during seed cotton cleaning using 2 six-cylinder cleaners, 1 stick machine and 2 separators.

Harvest conditions were near ideal, with low seed cotton moistures and low ambient air relative humidity. Cotton remaining on the plant after the picker passed ranged from 2.2 to 6.4 percent of the harvested yield. The 1-row picker operating at high speed was equal to or lower than the other machine/speed combinations in percent cotton remaining on the plant for all three varieties. Cotton that was dropped after beign picked ranged from 5.6 to 31.0 percent of the harvested yield. The 2-row picker was equal to or lower than the other machine/speed combinations in percent cotton dropped after picking for all three varieties. Trash removed during seed cotton cleaning ranged from 4.7 to 10.1 percent of the total yield. The 1-row picker had lower trash in the seed cotton regardless of operating speed for the Delta Pine and Acala varieties, while the 2-row picker had lower trash in the seed cotton for the Pima variety.

Results for harvest losses and trash content showed a highly significant interaction between variety and machine/speed combination. Adjustments to the picker head and conveying air speed can have a large effect on harvest losses and trash content. A follow-up study is planned which will include better control of the picker head adjustments and conveying air speed.

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